THE INTERNATIONAL MAGAZINE ... ODS FOR ENGINEERING/OPERATING PEOPLE

Petroleum Engineer INTERNATIONAL

JUNE 1984 $3.00 PER COPY

EXXON
ACQ. LIBRARY
GOVERNMENTAL INFO SVC
4526 E. WEST HWY/STE 800
BETHESDA MD 20814

INTERNATIONAL REPORT

109 Deep Wells Outside Of U.S., p. 21

Manifold Center OK At Cormorant, p. 28

Drilling Challenges At Belayim Field, p. 40

Floater Response To Blowouts, p. 64

Petroleum Engineer INTERNATIONAL

P.O. Box 1589 • Dallas, Texas 75221-1589
Ph 214-691-3911 • **TWX** 910-861-9306

Abbott Sparks — President
Jim Donnelly — Publisher
W. B. Bleakley — Editor
Richard D. McNally — Associate Editor
Steven D. Moore — Drilling Editor
Laura Jacobus — Assistant Editor
J. E. (Hank) Kastrop — Consulting Editor
Cynthia Mays — Research Manager
Mary DeLeon — Editorial Assistant
Sharon Hutcheson — Research Assistant
Bill Thornton — Marketing Manager
Dorothy Pate — Service Department

DISTRICT OFFICE
Harrison T. Brundage — Gulf Coast Editor
4151 Southwest Freeway, Suite 415, Houston, TX 77027

EDITORIAL ADVISORY COMMITTEE
Ted A. Armstrong, Director of Corporate Communications, Santa Fe International Corp.
Bennie L. Franks, Senior Vice President, Reserves Management and Technology, Sun Production Co.
R. D. King, Manager, Frontier Technology Department, Gulf Oil Exploration and Production Co.
James F. Massey, Vice President, Engineering and Operations, Hamon Oil Co.
Marius J. Mes, Senior Development Engineer, Phillips Petroleum Co.
Dennis E. O'Brien, Technology Division Manager, Performance Chemicals, Exxon Chemical Americas
L. Douglas Patton, L. D. Patton & Associates
George W. Perry, Executive Vice President, International Operations, Loffland Brothers Co.
Frank Schuh, Director, Drilling and Production Mechanics Research, ARCO Oil and Gas Co., a Division of Atlantic Richfield Co.

Jane Dietz — Production Department Manager
Don Fickert — Graphics Director
Debbie Cooper — Production Manager
Sherry Gritch — Presentation
Charles Miller — Presentation
James Duke — Presentation
Gary Hogan — Business Manager
Jack Schabel — Circulation Director

HARCOURT BRACE JOVANOVICH PUBLICATIONS
ROBERT L. EDGELL, Chairman; RICHARD MOELLER, President; LARS FLADMARK, Executive Vice President; THOMAS GRENEY, EZRA PINCUS, Senior Vice Presidents; ARLAND HIRMAN, Treasurer; JOE BILDERBACH, JAMES GHERNA, GEORGE GLENN, PAT O'ROURKE, HARRY RAMALEY, ABBOTT SPARKS, Vice Presidents. OFFICES: 7500 Old Oak Boulevard, Cleveland, Ohio 44130. Phone 216-243-8100; 1 East First Street, Duluth, Minnesota 55802. Phone (218) 727-8511; 111 East Wacker Drive, Suite 1730, Chicago, Ill. 60601. Phone (312) 938-2300.

ADVERTISING SALES OFFICES
EASTERN: Richard Martin, P.O. Box 89, Tennent, New Jersey 07763. (201) 446-3230.
CHICAGO, OHIO, WESTERN PA: Herb Abrahamson, 111 East Wacker Drive, Suite 1730, Chicago, Illinois 60601. (312) 938-2339.
LOS ANGELES 91106: Bruce Berkey, 61 S. Lake Ave., Box 4566, Pasadena, Calif. (213) 681-0685.
HOUSTON 77027: Barry Biklen, Mike Staton, 4151 Southwest Freeway, Suite 415, (713) 626-7850.
DALLAS 75221-1589: Ed Sealey, Rusty Meador, Mike Slaton, P.O. Box 1589, Dallas, TX. (214) 691-3911. TWX 910-861-9306.
UNITED KINGDOM, SCANDINAVIA, ITALY: Bryan Clark, Energy Publications Div. HBJ, 24 28 Oval Road, London NW1 7DX, England (01) 485-7074 or (01) 267-4466. Telex: 25775.
FRANCE, BELGIUM, SWITZERLAND: Gerard Lasfargues, 32 rue Desbordes Balmore, 75116-Paris, France. Telephone: 504 97 94.
JAPAN: Mashy Yoshikawa, Orient Echo, Inc., 11th Floor Sankyo Bldg., 7-12 Tsukiji 2-chome, Chuo-Ku, Tokyo, Telephone: 541-4923, Telex: MYORIENT J33376.
GERMANY, NETHERLANDS, AUSTRIA: SIPAS. **Wim J. M. Sanders, Paul J. Verbunt,** Oosterpark 6, P.O. Box 25 De Ryp, Holland. Telephone: 02997-1303 and 3660. Telex: 13039 SIPAS NL. Telegrams: SIPAS-Amsterdam.

HBJ A HARCOURT BRACE JOVANOVICH PUBLICATION

ABP ABC

Postmaster: Send address changes to PETROLEUM ENGINEER INTERNATIONAL, P.O. Box 1589, Dallas, Texas 75221-1589, USA.

Drilling Upturn Reflects Return To Normalcy

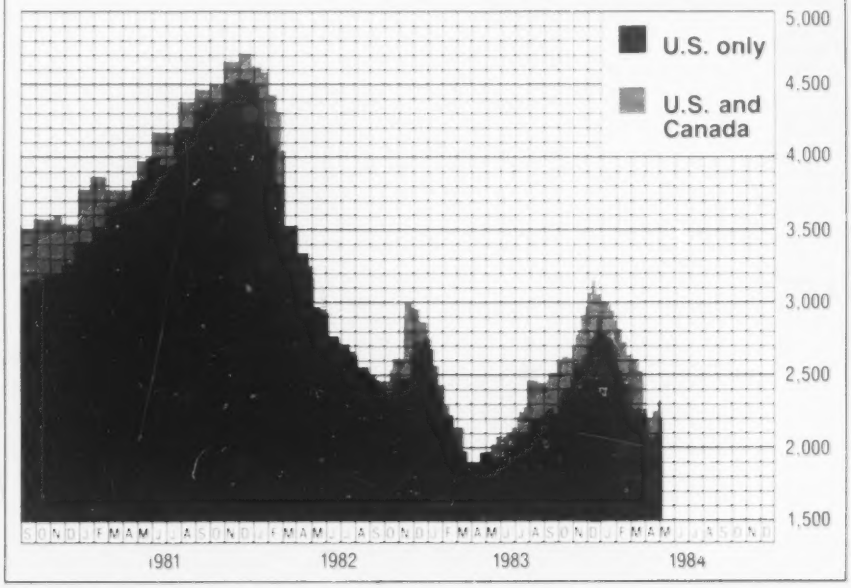
For the first time this year, every week covered in the accompanying table reflects an increase in U.S. rotary rig activity over the preceding week. And the recovery came right on schedule, which indicates that the pattern of drilling in the U.S. may be returning to normal after having soared to breath-taking heights in 1981.

Canada also seems to be reverting to traditional patterns of activity, with slow going for rigs during the spring thawing season. As a rule, most drilling in Canada gets done in the winter. And this year, after topping off at 361 in early March, the Canadian rig count dropped steadily until it reached two figures by the end of April. It moved back into three figures in early May, but we'd be surprised to see it return to the 360-level before next winter.

Rotary rigs actually making hole in United States & Canada

As Reported To International Association Of Drilling Contractors By Hughes Tool Co.

	Apr. 16, 1984	Apr. 23, 1984	Apr. 30, 1984	May 7, 1984
Alabama				
Land	11	10	12	14
Inland Waters	2	2	2	2
Offshore	2	2	2	2
Alaska				
Land	11	11	11	12
Offshore	2	2	2	3
Total	13	13	13	15
Arkansas	24	26	25	21
Arizona	1	1	1	1
California				
Land	79	76	81	84
Offshore	15	17	14	16
Total	94	93	95	100
Colorado	44	47	48	47
Florida	2	2	2	2
Hawaii	1	1	1	1
Illinois	9	13	22	33
Indiana	5	5	4	4
Kansas	89	114	114	95
Kentucky	3	3	4	6
North Louisiana	25	27	28	33
South Louisiana				
Inland Waters	44	43	46	48
Land	83	91	91	89
Offshore	125	123	125	123
Total	287	284	290	293
Michigan	15	15	26	29
Mississippi	29	32	28	27
Montana	27	27	24	25
Nebraska	7	8	9	8
Nevada	7	7	6	8
New Jersey	1	1	1	1
New Mexico	76	72	78	79
New York	3	8	7	7
North Dakota	44	46	45	46
Ohio	25	24	29	34
Oklahoma	279	297	304	311
Pennsylvania	19	22	24	25
South Carolina	1	1	1	1
South Dakota	1	1	1	1
Texas				
Offshore	61	61	61	57
Inland Waters	6	6	5	7
Dist. 1-S. Central Tex.	22	22	17	22
Dist. 2-Middle Tex. Coast	37	35	41	32
Dist. 3-Upper Tex. Coast	99	91	89	88
Dist. 4-Lower Tex. Coast	72	74	69	72
Dist. 5-Northeast Tex.	37	41	37	28
Dist. 6-Far Northeast Tex.	66	59	63	68
Dist. 7B-N. Central Tex.	48	52	52	47
Dist. 7C-W. Central Tex.	55	55	65	63
Dist. 9-Far West Tex.	133	133	127	134
Dist. 8A-West Tex.	66	66	67	60
Dist. 9-North Tex.	70	76	49	77
Dist. 10-Tex. Panhandle	47	50	49	47
Total	819	821	817	802
Utah	40	38	43	42
Virginia	4	4	5	5
West Virginia	27	33	32	31
Wyoming	96	93	84	82
Total U.S.	2,107	2,156	2,199	2,200
Canada	116	85	76	103
Canada-Offshore	13	14	14	14
U.S. and Canada	2,236	2,255	2,289	2,317


U.S. only
U.S. and Canada
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1981
1982
1983
1984

PETROLEUM ENGINEER INTERNATIONAL (USPS 01648321) published 15 times each year, monthly plus March 15, July 15, and November 15, by Energy Publications Division, Harcourt Brace Jovanovich, P.O. Box 1589, Dallas, Texas 75221-1589. Accounting and Circulation offices: 1 East First Street, Duluth, Minnesota 55802. June 1984, Volume 56, No. 7. Copyright © 1984 by Harcourt Brace Jovanovich, Inc. All rights reserved. No part of this publication may be transmitted or reproduced in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without permission in writing from the publisher. Subscription rate to personnel employed by companies involved with exploration, drilling, or production of oil or gas: one year $16.00, three years $32.00 for North, Central, and South America. Outside North, Central, and South America: one year $35.00, three years $55.00. Subscription rate for all others: $50.00 for one year. Single copy price $3.00. Second class postage paid at Duluth, Minnesota and additional mailing offices. Microfilm copies are available through University Microfilms, Inc., 300 North Zeeb Road, Ann Arbor, Michigan 48106. Indexed by Applied Science, Technology Index, and the Engineering Index, Inc.

Petroleum Engineer INTERNATIONAL

The international magazine of methods for engineering operating people

JUNE 1984 NUMBER 7 VOLUME 56

21

40

50

INTERNATIONAL REPORT

International Deep Drilling Costs Approach $2 Billion 21

by Harrison T. Brundage, Gulf Coast Editor. In 1983, 54 different operators drilled and completed deep wells in 29 countries of the Free World. Probable discoveries were made in 27 of 86 wildcats and in six of eight development wells.

Shell-Esso Succeeds With Cormorant UMC 28

by Steven D. Moore, Drilling Editor. Because the platform and the underwater manifold center are 4 miles apart, the project team developed a specially insulated pipe to prevent oil being piped through the flow lines from cooling.

Egypt's Belayim Field Challenges Drillers 40

by Ermenegildo Possamai, AGIP S.p.A., and Ezz Mohamed Fandi, Petroleum Belayim Co. Extra production needed to reach a 200,000-b/d goal will come from 19 new single wells included in the offshore expansion program.

10th Annual Competition Recognizes Engineering Innovators 50

Some 19 winners of Special Meritorious Awards for Engineering Innovation were chosen by a distinguished panel of engineers and engineering managers from operating companies in the petroleum industry.

Electrical Submersible Pump Teardown Inspection, Part 3 56

by James F. Lea, Amoco Production Co., and William J. Powers, TRW Reda. Manufacturers normally recommend air checks on the bottom seal at 3 to 4 psi for leaks and air checks at 5 psi on the fluid check valve.

How Floaters Respond To Subsea Blowouts 64

by Jerome Milgram, Massachusetts Institute of Technology, and Paul R. Erb, Conoco Inc. Recent technical studies clearly demonstrate that actual loss of buoyancy in a blowout is quite small for all reasonable water depths.

DEPARTMENTS

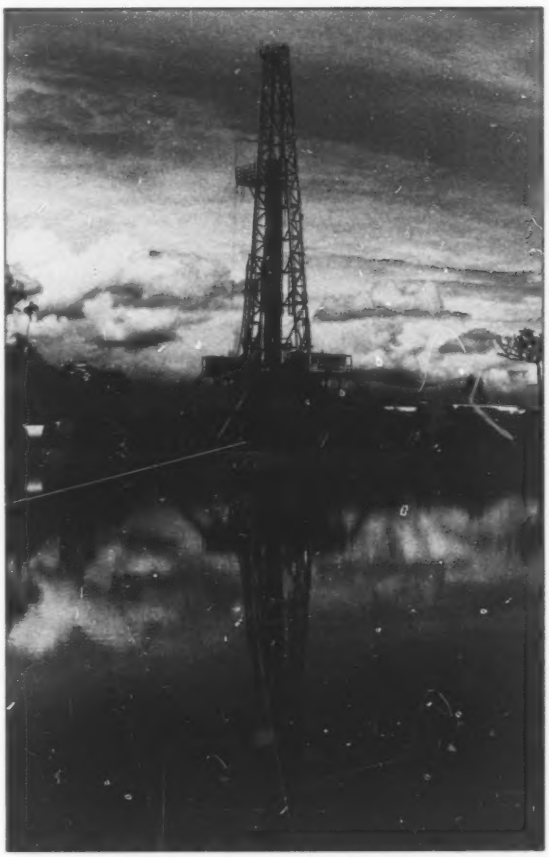
NEWS HI-LITES	1	DO YOU REMEMBER?	82	ENERGY MANAGEMENT REPORT	
COURSE OF OIL	6	CONTINUOUS TABLES	83	COMMENT	EM-1
TECHNOLOGY TRENDS	8	PETROLEUM PROFILES	86	ENERGY WORLD NEWS	EM-2
OFFSHORE TECHNOLOGY	10	COMPANY NEWS	97	CLASSIFIED	EM-3
DRILLING/EXPLORATION	76	INDEX TO ADVERTISERS	EM-8	FINANCIAL NOTEBOOK	EM-3
INDUSTRY MEETING CALENDAR	81			NEW PRODUCTS	EM-4

ABOUT THE COVER. A drilling crew makes hole on Marathon's Brae A platform in the UK sector of the North Sea. (Photo courtesy of Marathon Oil Co.)

NEXT MONTH. The Well Completions and Workover Report in July will discuss tools involved in servicing 500,000 wells on some form of artificial lift.

International Deep Drilling Costs Approach $2 Billion

by Harrison T. Brundage, *Gulf Coast Editor*



This is Rig 216, a helirig rated to 25,000 ft, owned by Parker Drilling Co., Tulsa, Okla. This unit was used to drill several offset and exploratory wells in Colombia, South America. (Photo courtesy of Parker Drilling Co.)

Exploratory and development drilling below depths of 15,000 ft (4,572 m) are soon expected to cost over $2 billion per year. A recent survey by PETROLEUM ENGINEER INTERNATIONAL indicates that worldwide deep drilling expenditures were $1,733,960,440 in 1983, with total drilling footage of almost 2 million ft. About 30 deep wells were being drilled by year-end in the non-Communist world outside the U.S. About 20 wells expected to be completed at depths greater than 15,000 ft were evidently under way in the Soviet Union.

This survey stresses wildcats, since most of the wells included were originally listed by Petroconsultants, an international firm concerned largely with exploration. Some development drilling is under way to these depths, however, in Canada, Latin America, the North Sea, West Germany, Italy, and the Middle East. Increased drilling can be expected as these plays accelerate and more finds are made at great depths, requiring subsequent development.

Last year, 54 different operators drilled and completed deep wells in 29 countries in the non-Communist world. They employed contractors of various nationalities, including Brazilian, Spanish, French, Norwegian, British, Libyan, Italian, Canadian, and American. They completed 94 wells in the non-Communist world. The USSR completed an estimated 15 deep wells, for a worldwide total of 109.

Probable discoveries were made in 27 of the 86 wildcats (31%). Six of eight development wells found pay in the deep objectives (75%). The overall success ratio was 35%.

Total mud costs for the non-Communist world amounted to $76,447,349, for an average cost per well of $813,270. Average mud costs were highest in Canada ($1,806,094 per well) where average depth was 19,001 ft (5,792 m) – and lowest in Western Europe at $551,516 per well, where average depth was 17,554 ft (5,351 m).

Bit use averaged 53 per well in the non-Communist world, for an average of 366 ft (112 m) per bit.

Bit usage in Western Europe averaged 72 per well, influenced largely by hard drilling in Spain and other areas close to the indurating influence of the Pyrenees and the Alps. Hard drilling in basins near the Andes in Colombia had a similar effect on bit usage in Latin America.

In the North Sea, bit usage averaged 34 per well. Deep drilling experience is gaining momentum, and specialized bit use makes for efficient drilling, particularly for exploitation work.

Canada's deep frontier wildcats were by far the world's most expensive – averaging $46,476,946 per well in 1983. However, they had a good success ratio, 3:8, or 37.5%. Shell Canada Resources Ltd. found gas at Glenelg J-48 – TD was 16,890 ft. Subsequently Shell has made another deep gas find in its offshore Nova Scotia drilling program.

Latin America continues to lead non-Communist world deep drilling regions, with 31 wells completed

last year. There were five Venezuelan discoveries out of 19 wells completed there. Drilling activity centered in the Urdaneta, Ceuta, and Alpuf areas.

The North Sea remains active, with 18 completions last year averaging $15,055,638 per well. Included were 14 wildcats and 4 development wells, with an overall success ratio of 39% (7 wells productive). In February 1984, Burmah Oil Exploration Ltd. completed an additional well, 22/2, in the UK sector, to 18,030 ft TD, as an oil well.

In continental Europe, OMV Aktiengesellschaft reached total depth of 28,054 ft (8,551 m) at Zisterdorf Ubertief 2A well. In March 1984, the well was waiting on completion, having found gas. This well is believed to be the deepest well drilled in the world outside the U.S. and USSR.

West Germany has become a mature province for deep development drilling. Deep drilling for pre-salt, gas-bearing Rotliegendes sandstone in the Soehlingen field area has been described recently.[1]

In Italy, deep drilling in the Milan-Po Valley area continues. Five deep wells were completed in Italy last year, one in Sicily, three in France, and four in Spain. African deep drilling included one well each in Gabon and Egypt, and three in Libya.

In the Middle East, deep drilling is centered in basinal areas near the Strait of Hormuz, where Mesozoic and Permian gas is being developed, and abnormal pressure regimes are being studied.

In the Far East, western Australia is becoming a deep drilling province. Interesting plays are developing, particularly in the Timor Sea. A deep drilling play is under way in New Zealand, where Shell NZ, as operator for Shell BP Todd, successfully completed the deep Kapuni well last October. Total depth was 18,582 ft. In Japan, two deep gas wells were completed last year. A deep geothermal drilling program has been planned in Japan for several years.

In Indonesia, generally there is little drilling to 15,000 ft. The basement is shallow in most areas, and high temperatures occur at shallow depths also, due to widespread vulcanism. In Kalimantan, however, one operator completed a highly productive well to about 14,990 ft TD, just shallow enough to be excluded from this report. Deeper wells will be drilled in the area in search of deeper pay zones.

This is Parker Drilling Co. Rig 140, a helirig rated to 20,000 ft. During 1983, the rig was used to drill some difficult-access wells in Papua, New Guinea. (Photo courtesy of Parker Drilling Co., Tulsa, Okla.)

Country-by-country analysis of 1983 international deep wells

	Wells completed or TD'd	Average depth, ft
Canada	**8**	**19,001**
Latin America	**31**	**16,817**
Argentina	1	16,965
Bolivia	1	15,079
Brazil	4	16,252
Colombia	4	17,447
Ecuador	1	15,428
Guatemala	0	0
Peru	1	16,916
Venezuela	19	16,954
North Sea	**18**	**15,983**
Netherlands	2	16,032
Norway	5	15,883
United Kingdom	11	16,020
Other Western Europe	**17**	**17,554**
Austria	1	28,054
France	3	16,683
Italy	5	17,087
Sicily	1	17,513
Spain	4	16,644
West Germany	3	16,927
Africa	**5**	**15,655**
Egypt	1	15,524
Gabon	1	15,321
Libya	3	15,810
Middle East	**6**	**16,131**
Dubai, United Arab Emirates	1	15,400
Qatar	1	16,190
Ras Al Khaimah	1	15,743
Sharjah	1	16,501
Turkey	1	15,840
Umm Al Qawain	1	17,502
Far East	**9**	**15,886**
Australia	5	15,357
Japan	2	15,682
New Zealand	1	18,582
Pakistan	1	16,240
Non-Communist World	**94**	**16,775**
USSR	**15**	**16,400**

Soviet Deep Drilling

Despite use of poor equipment and generally obsolete drilling practices, the Soviet Union is making progress, and gaining experience in drilling below 15,000 ft. With many old, shallow oil and gas fields being depleted, the USSR is urging its oil industry to drill deeper. Much money and effort are being directed to deep drilling.

Russians still stress use of domestically made turbodrills, which contain poor steel, perform badly, and average only about 345 to 985 ft (105 to 300 m) per rig per month. Some average only 230 ft (70 m) per month at 15,000 ft and below.

Still, some favorable results are being obtained because of massive efforts. Good results are reported in the old Baku oil province, both offshore in the Caspian Sea and in adjacent onshore areas. Production from Pliocene sandstones there may be comparable to U.S. Gulf Coast Pliocene production. These offshore wells are located north and east of the Apsheron Peninsula.

Development wells are being drilled to 19,030-685 ft (5,800-6,000 m) offshore Sangachaly, Duranyy, Bulla, Bulla Island, and other fields. These wells require 2 to 3 years to complete.

Soviets found the 28th of April field about 6 years ago, tested it in 1980, and started commercial production by late 1981. They claim it to be the world's deepest offshore producing field, with one gas well flowing as much as 35 MMcfd, and 14 oil wells yielding 13,000 b/d by mid-1983.

Bulla More is a huge offshore gas-condensate field, found in 1973. By 1983, it had 30 producing wells. Well 16 reached 19,865 ft (6,055 m) TD, and tested 24.5 MMcfd and 1,460 b/d of condensate from 16,798-19,865 ft (5,120-6,055 m). Average total depth for the field is 19,717 ft (6,010 m). The deepest pool was found at 20,138-249 ft (6,138-172 m) in June 1982, and a deeper test is being drilled. Bulla More reserves are put at 5.1 tcf, plus 290 million bbl of condensate. A late 1983 well found 1,000 b/d production at 20,111 ft (6,130 m), with gas flow of 2.5 MMcfd.

In the North Caucasus, Groznyy district, Terek basin, a record well reached 17,287 ft (5,269 m) in Triassic in 1980. Of 16 wells programmed for 14,435-ft (4,400-m) completion in 1980, 13 failed to reach objec-

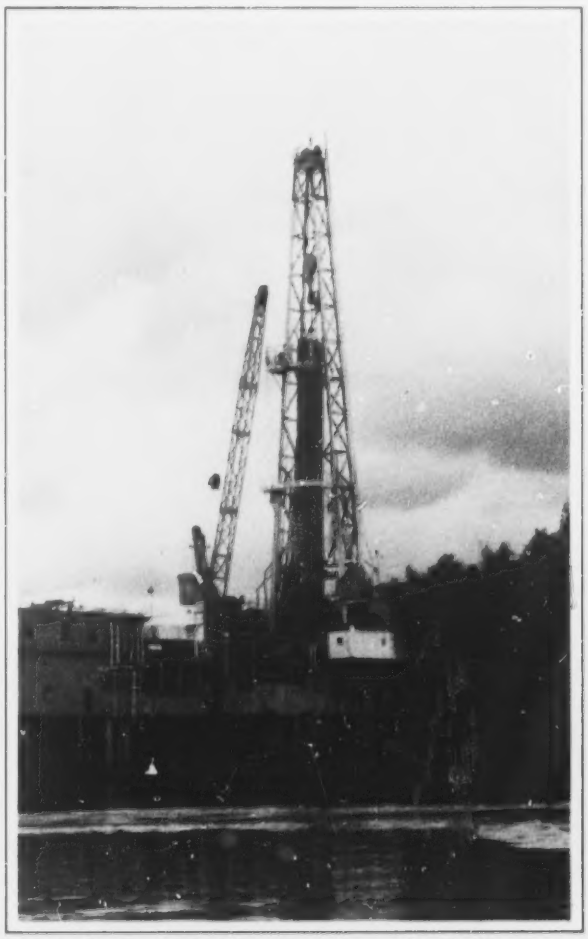
Worldwide Deep Drilling
Wells drilled to 15,000 ft or deeper

Average well depth	16,856 ft 5,138 m
Average cost well	$15,907,894 ($944 ft) ($3,096 m)
Average mud cost*	$813,270 ($48 ft) ($158 m)
Average bits well*	53 (366 ft bit) (112 m bit)
Success ratio*	35% (94 wells)
Exploratory success ratio	31% (86 wells)
Development success ratio	75% (8 wells)
Total costs: Mud	$76,447,349
Drilling	$1,360,133,822
Completion	$171,994,831
Total costs**	$1,733,960,440
Total footage	1,837,271 ft (560,007 m)

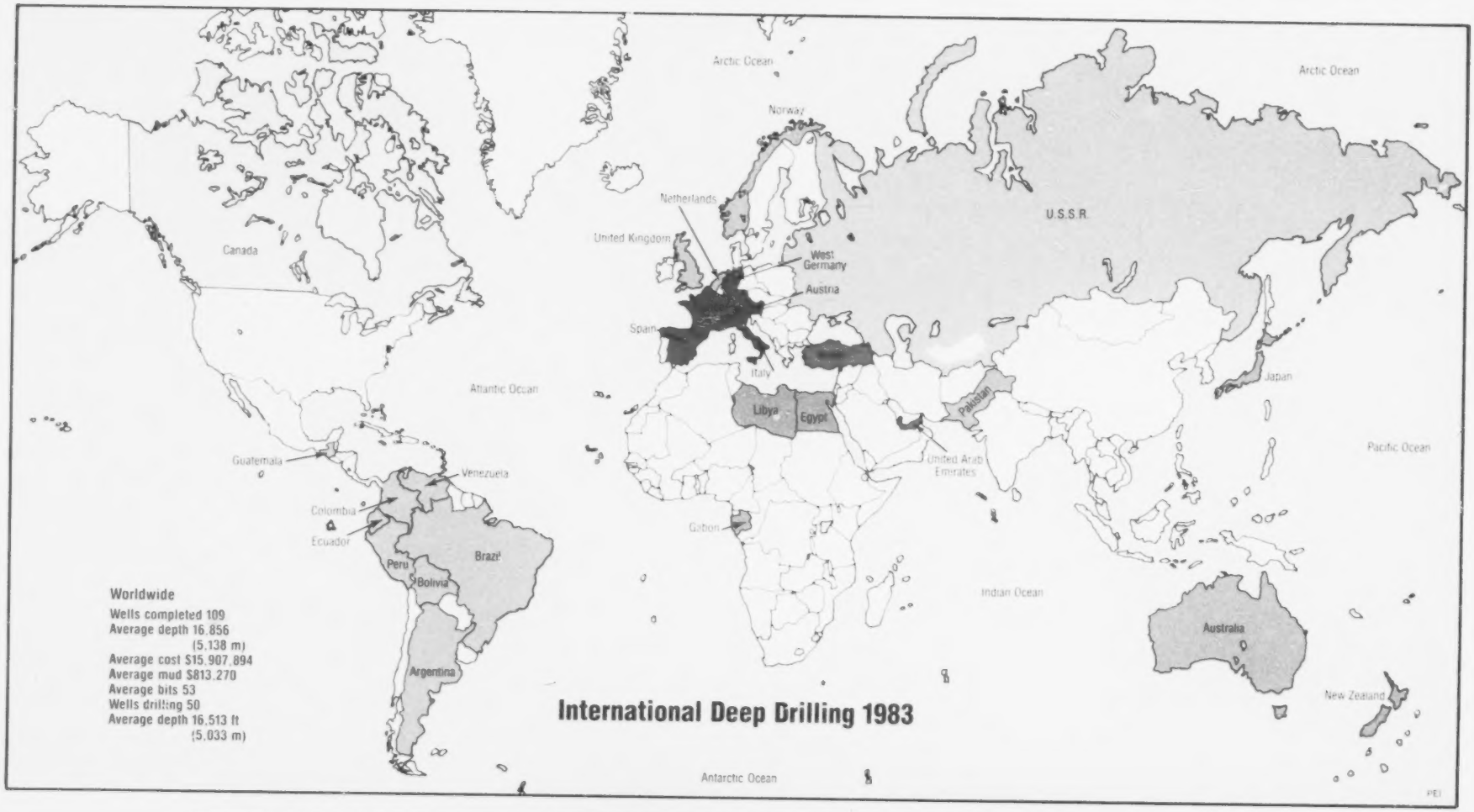
*Mud costs, bit use data, and success ratios of Communist countries are excluded from this tabulation, since they generally are not published in up-to-date form.
**Total costs throughout this article include drilling and completion costs, as well as other incremental costs, such as rig mobilization and demobilization as may be appropriate.

	Canada	USSR
Average well depth	19,001 ft (5,792 m)	17,285 ft (5,268 m)
Average cost well	$46,476,946 ($2,446 ft) ($8,025 m)	$11,213,333
Average mud cost	$1,806,094 ($95 ft) ($312 m)	
Average bits well	57.6 (330 ft bit) (101 m bit)	
Success ratio	38% (8 wells)	
Exploratory success ratio	38% (8 wells)	
Development success ratio	—	
Total costs: Mud	$14,448,750	
Drilling	$265,714,787	
Completion	$103,189,916	
Total costs	$371,815,568	$168,200,000*
Total footage	152,009 ft (46,333 m)	

*Estimated cost figures, based on 15 wells drilled, excluding superdeep stratigraphic drilling.



This is the Rowan Drilling Co. submersible drilling barge, Morgan City, drilling in Balikpapan, Indonesia. The Morgan City can operate in 26 ft of water depth, to 25,000-ft depths. (Photo courtesy of Rowan Drilling Co., Houston, Tex.)



Canada
Wells completed 8
Average depth 19,001 ft
(5,792 m)
Average cost $46,476,946
Averge mud $1,806,094
Average bits 58
Wells drilling 4
Average depth 17,190 ft
(5,240 m)

Latin America
Wells completed 31
Average depth 16,817 ft
(5,126 m)
Average cost $12,929,018
Average mud $866,857
Average bits 61
Wells drilling 6
Average depth 16,394 ft
(4,997 m)

North Sea
Wells completed 18
Average depth 15,983 ft
(4,872 m)
Average cost $15,055,638
Average mud $810,914
Average bits 34
Wells drilling 5
Average depth 16,386 ft
(4,995 m)

Africa
Wells completed 6
Average depth 15,655 ft
(4,772 m)
Average cost $17,784,454
Average mud $1,092,698
Average bits 42
Wells drilling 2
Average depth 15,371 ft
(4,685 m)

Far East
Wells completed 9
Average depth 15,886 ft
(4,842 m)
Average cost $13,633,022
Average mud $428,924
Average bits 37
Wells drilling 4
Average depth 16,112 ft
(4,911 m)

USSR
Wells completed 15
Average depth 17,285 ft
(5,268 m)
Average cost $11,213,333

tives, and were junked and abandoned because of faulty equipment. Three reached the objective. One was a discovery. Average time to drill was 4½ years per completed well.

In the Dnepr-Donets Permo-Carboniferous sandstone graben, Ukraine, a 15,252-ft (4,649-m) test at Sagadayak salt dome required 34 months to drill. Only two of the 12 wells reached target depth of 16,932 to 17,195 ft (5,161-241 m).

In the Timan-Pechora basin, Komi Republic, by January 1983 six tests had been drilled below 18,044 ft (5,500 m) at Vuktyl gas field. On a fixed platform in the Pechora Sea, the first 16,400-ft (5,000-m) well was completed early in 1983.

The North Caspian basin, Astrakhan gas field, found in 1976, is huge, with up to 40% H_2S and CO_2 content. Production depth is 9,186 to 16,400 ft (2,800 to 5,000 m). In June 1982, there were a reported 45 rigs drilling 5,000-m wells in the southwestern part of the North Caspian basin. At Kenkiyak and Aransay fields, oil has been found below salt, as deep as 15,092 ft (4,600 m). Deep drilling plays are under way also on the Emba uplift.

In Southeast Turkmenia, gas has been found as deep as 16,400 ft (5,000 m) at Dauletabad-Donmez gas field.

In the West Siberian basin, several deep plays are under way. At Urengoy, the world's largest gas field (262.5 tcf proved in Cretaceous sandstones), the deepest well was completed in May 1983 at 16,473 ft (5,021 m).

Well costs are published in Soviet drilling and economic journals, generally from 1½ to 3 years or more after completion. No doubt such costs vary greatly by areas, depending on whether drilling has long been done in a favorable environment, such as the Baku-

USSR recent deep drilling developments

Area, district, or field	Approx. depth, ft	Approx. cost/well, converted to U.S.$
Offshore Caspian Sea, NE of Apsheron Peninsula, at Baku	16,800-22,150	13,500,000-25,000,000
Cheleken district, onshore E of Caspian Sea, Kara-Tepe field	17,225	8,200,000
Timan-Pechora basin, Komi Republic, Vuktyl gas field	18,000	9,000,000
North Caspian basin, lower Volga area	16,400	8,500,000
Southern Volga-Urals basin, Volgograd district, Sudovsk field	15,400	8,000,000
West Siberian basin, Urengoy gas field	16,400	9,000,000
Vilyuy basin, eastern Siberia, gas fields	15,750	10,000,000
Dagestan area, north of North Caucasus basin	18,000	10,000,000

	Latin America	North Sea	Middle East
Average well depth	16,817 ft 5,126 m	15,983 ft 4,872 m	16,219 ft 4,944 m
Average cost/well	$12,929,018	$15,055,638	$12,974,433
	($769 ft) ($2,522 m)	($942 ft) ($3,090 m)	($800 ft) ($2,625 m)
Average mud cost	$866,857	$610,914	$905,000
	($52 ft) ($169 m)	($38 ft) ($125 m)	($56 ft) ($184 m)
Average bits/well	61.0	33.5	48.5
	(276 ft bit) (84 m bit)	(477 ft bit) (145 m bit)	(334 ft bit) (102 m bit)
Success ratio	23% (31 wells)	39% (18 wells)	83% (6 wells)
Exploratory success ratio	23% (31 wells)	29% (14 wells)	80% (5 wells)
Development success ratio	—	75% (4 wells)	100% (1 well)
Total costs: Mud	$26,872,571	$10,996,450	$5,430,000
Drilling	$387,617,377	$245,004,487	$68,408,164
Completion	$7,525,000	$21,769,000	$7,438,432
Total costs	$400,799,572	$271,001,487	$77,846,596
Total footage	521,316 ft (158,899 m)	287,699 ft (87,692 m)	97,313 ft (29,661 m)

	Western Europe Other than North Sea	Africa	Far East
Average well depth	17,554 ft 5,351 m	15,655 ft 4,772 m	15,886 ft 4,842 m
Average cost/well	$13,686,926	$17,784,454	$13,633,022
	($780 ft) ($2,558 m)	($1,136 ft) ($3,727 m)	($858 ft) ($2,816 m)
Average mud cost	$551,516	$1,092,698	$428,924
	($31 ft) ($103 m)	($70 ft) ($230 m)	($27 ft) ($89 m)
Average bits/well	72.2	42.0	37.4
	(243 ft bit) (74 m bit)	(373 ft bit) (114 m bit)	(425 ft bit) (129 m bit)
Success ratio	24% (17 wells)	40% (5 wells)	56% (9 wells)
Exploratory success ratio	14% (14 wells)	40% (5 wells)	56% (9 wells)
Development success ratio	67% (3 wells)	—	—
Total costs: Mud	$9,375,770	$5,463,488	$3,860,320
Drilling	$206,692,057	$71,906,750	$114,790,200
Completion	$18,686,101	$5,861,382	$7,525,000
Total costs	$232,677,750	$88,922,272	$122,697,200
Total footage	298,411 ft (90,957 m)	78,275 ft (23,859 m)	142,973 ft (43,579 m)

1983 International Deep Well Operators

AGIP
AGIP North Africa & Middle East Ltd.
Amoco Production Co. International
Amoco (UK) Exploration Co.
ARCO International Oil and Gas Co.
The British Petroleum Co. plc
Britoil plc
Burmah Oil Exploration Ltd.
Conoco (UK) Ltd.
Corporacion Estatal Petrolera Ecuatoriana (CEPE) (Ecuador)
Corpoven SA
Deutsche Texaco AG
Elf Aquitaine Norge
Elf Gabon
Elf Italia SpA
Elwerath Betriebsfuhrungs GmbH
Empresa Nacional de Investigacion y Explotacion de Petroleo SA (Eniepsa) (Spain)
Gewerkschaften Brigitta
Gulf Oil Exploration and Production Co.
Gulf Oil (UK) Ltd.
Intercol
International Egyptian Oil Co.
Lagoven SA
Maraven SA
Meneven SA
Mobil Oil AG
Mobil Oil Canada Ltd.
Montedison
Nederlandse Aardolie Mij. (NAM)
Norsk Hydro
Norske Shell
Occidental Exploration and Production Co.
Oil & Gas Development Corp. (OGDC) (Pakistan)
OMV Aktiengesellschaft (Austria)
Panarctic Oils Ltd.
Pecten International
Petro-Canada
Petroleo Brasileiro (Petrobras)
Petroland BV
Phillips Petroleum Co. Norway
Qatar General Petroleum Corp.
Shell Australia
Shell Canada Resources Ltd.
Shell Française
Shell NZ (operator for Shell BP Todd)
Société Nationale Elf Aquitaine (Producing) – SNEA (P)
Superior Oil Co.
Teikoku Oil Ltd.
Texpet
Turkiye Petrolleri A.O.
West Australia Pty. Ltd. (Wapet)
Woodside Petroleum Development
Yacimientos Petroliferos Fiscales (YPF)
Yacimientos Petroliferos Fiscales Bolivianos

The Rowan Gorilla I, a huge self-elevating platform drilling unit with 503-ft legs, is shown in service offshore in the Sable Island area, offshore Halifax, Nova Scotia, Canada. (Photo courtesy of Rowan Drilling Co., Houston, Tex.)

1983 International Deep Well Contractors*

Arab Drilling and Workover Co. (Adwoc)
Braspetro
Compañia General de Sondeos
Dolphin
Foramer
Forasol
Forex Neptune
Global Marine Drilling Co.
Ideco
Jebsens Offshore Drilling Ltd.
Maersk Drilling Services
Morco
National Drilling Co. of Libya
Odeco
Olsen
OMV Aktiengesellschaft
Parker Drilling Co.
Pergemine
Petroleo Brasileiro S. A. (Petrobras)
Reading & Bates Drilling Co.
Rowan Drilling Co.
Saipem
Santa Fe Drilling Co.
Sedco
Sonat Offshore Drilling Inc.
Sonpetrol
Spartan Drilling Ltd.
Texpet
W. Wilhelmsen
Wodeco
Zapata Off-Shore Co.

*Specifically identified by operators responding to PEI's deep drilling survey.

Caspian area, or in remote, harsh environments, such as in most of Siberia. Cost figures published here are estimated from limited data available.

Other Promising Deep Basins

Egypt has begun deep drilling in the Gulf of Suez region, with one well completed last year. In Israel, good oil prospects exist in the Dead Sea area, in block-faulted sediments at 20,000 ft or deeper. Nigeria is apt to have more deep drilling in the future, with 40,000 ft or more of sediments believed to be present in the Niger River delta and offshore.

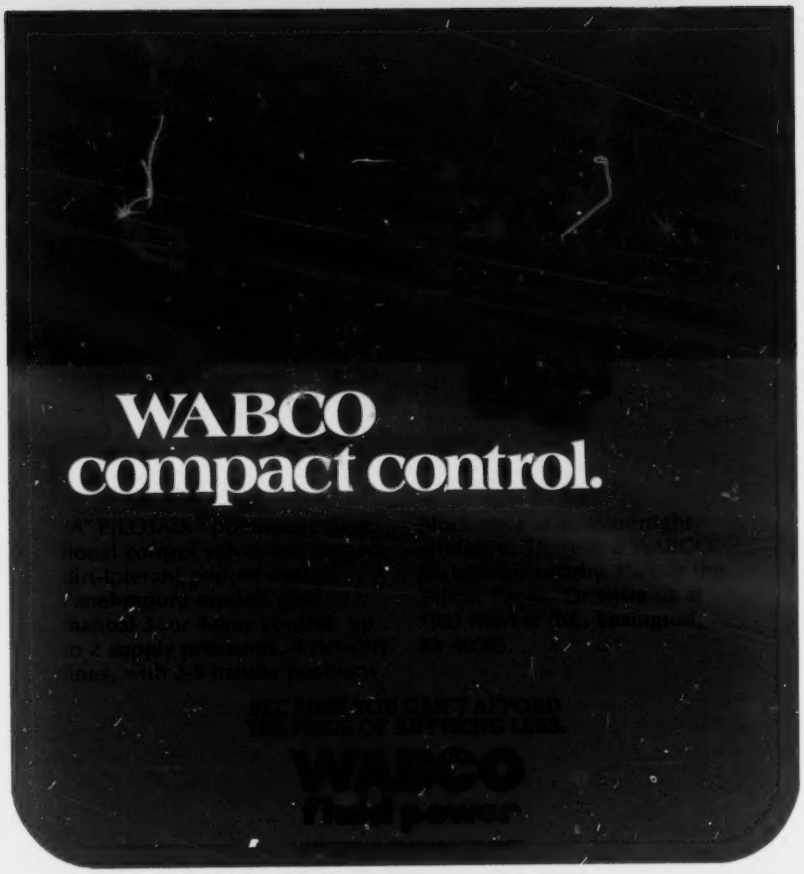
Many offshore deepwater areas on marine abyssal plains could become deep drilling trends, as deepsea drilling technology progresses.

Guatemala is undergoing a deep drilling play. Last November, Texaco Exploration Guatemala Inc. spudded a 17,000-ft test which was drilling at year-end.

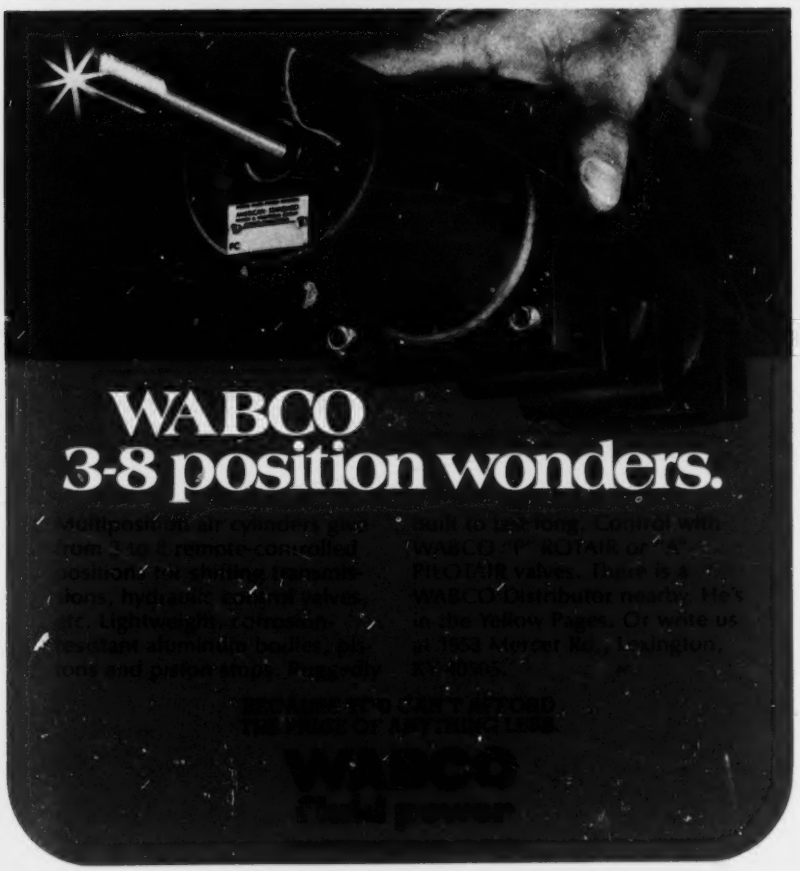
Acknowledgement. The author thanks the many individuals and companies who aided in preparation of this report. Most raw well data were provided by Petroconsultants, arranged through the Houston, Tex., office by Joseph Summa and Richard Fletcher. Most data on the USSR were provided by A. A. Meyerhoff of Tulsa, Okla.

References

1. Bleakley, W. B.: "Mobil AG Scores With Massive Frac," *Pet. Eng. Intl.* (January 1984) 72-83. ■



Circle 247 on Reader Service Card



International Count Down By 100 Rigs

The international rotary rig count was a little more than 100 rigs behind the year-earlier count in March, after having been more than 200 rigs behind in January. But it is too early to tell whether world drilling is ready to stage a recovery.

Biggest loser so far this year continues to be Algeria, where drilling is down by almost 70%. This, in turn, has caused Africa to be the main culprit among regions for the decline in Hughes Tool Co.'s International Rotary Drilling Rig Report. Drilling is down in all regions, however, except for the South Pacific.

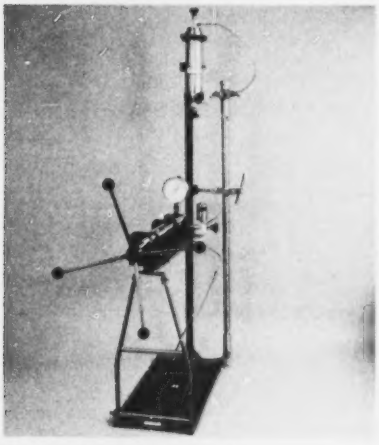
International Rotary Rig Report, prepared by Hughes Tool Co.
(Figures in parentheses indicate how many of each country's rigs are offshore rigs.)

	March 1983	Feb. 1984	March 1984
Africa			
Algeria	80	30	25
Angola	13(9)	5(3)	5(3)
Benin	1(1)	1(1)	1(1)
Cameroon	6(6)	4(4)	4(4)
Gabon	9(8)	9(8)	8(7)
Ivory Coast	2(2)	2(2)	2(2)
Libya	23(2)	28(2)	29(2)
Morocco	5	5	4
Niger	1	1	1
Nigeria	19(10)	13(5)	10(6)
Rep. of Congo	5(5)	4(4)	4(4)
Rep. of Zaire	2(1)	2(1)	2(1)
South Africa	2(2)	2(2)	2(2)
Sudan	5(1)	3	3
Tanzania	0	1	1
Tunisia	11(3)	6(1)	6(1)
	184(50)	116(33)	107(33)
Europe			
Austria	9	8	8
Denmark	5(4)	3(3)	3(3)
France	15(1)	21(1)	21(1)
Germany	30	16	15
Greece	3(1)	4(1)	4(1)
Holland	16(11)	17(9)	17(9)
Ireland	0	1(1)	1(1)
Italy	33(7)	25(7)	23(6)
Norway	10(10)	8(8)	11(11)
Portugal	1	0	0
Spain	9(5)	7(3)	5(2)
Switzerland	1	0	0
United Kingdom	39(1)	49(45)	57(54)
Yugoslavia	25	21(2)	27(2)
	196(77)	180(80)	190(90)
Far East			
Bangladesh	1	3	3
Brunei	10(7)	9(6)	8(6)
Burma	41(1)	33(1)	33(1)
India	54(12)	57(16)	56(16)
Indonesia	87(23)	86(28)	81(24)
Japan	18(2)	22(3)	18(3)
Korea	0	1	1
Malaysia	9(9)	9(9)	9(9)

Circle 248 on Reader Service Card

LEUTERT™

INSTRUMENTS · OIL INDUSTRY EQUIPMENT



Bottom Hole Sampler with Field Transfer System

THE LEUTERT SAMPLING SYSTEM IS THE MOST WIDELY USED IN THE INDUSTRY TODAY.

Other Products:
- DYNAMOMETERS
- PVT EQUIPMENT
- CHART READING MICROSCOPES
- TEMPERATURE GAUGES
- MECHANICAL & ELECTRONIC SUBSURFACE PRESSURE GAUGES

Leutert Instruments, Inc.
5725 Hartsdale
Houston, Texas 77036
USA
Tel. 713/781-0641
Telex: 795279

Friedr. Leutert GmbH & Co.
P.O. Box 1111
2126 Adendorf
F. R. GERMANY
Tel. 04131/51032
Telex: 02-182160

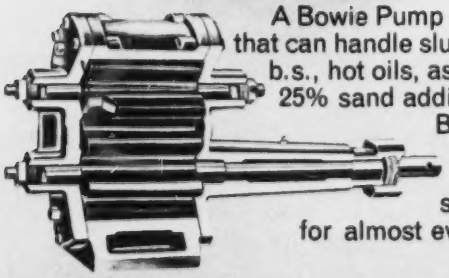
Leutert (North Sea) Ltd.
North Esplanade West
Aberdeen AB1 2RJ
Scotland
UNITED KINGDOM
Tel. 0224/54291
Telex: 739341

Agents Worldwide

Circle 250 on Reader Service Card

BOWIE PUMPS

we get to the bottom of things



A Bowie Pump is a rotary pump that can handle slurries, salt water, b.s., hot oils, asphalt (even with 25% sand additive), or water. Bowie Pumps are available in a selection of series and sizes for almost every application.

write for free catalog

BOWIE INDUSTRIES, INC.
P.O. Box 931 Bowie, Texas 76230
(817) 872-2286

Drilling/Exploration...

Pakistan	17	17	17
Philippines	9	4(2)	4(1)
Taiwan	0	2	5
Thailand	11(6)	11(6)	11(6)
	257(60)	253(71)	246(66)
Latin America			
Argentina	63(1)	82	82
Barbados	1	1	1
Bolivia	6	6	6
Brazil	98(34)	67(24)	65(21)
Chile	6(3)	5(3)	5(3)
Colombia	18	14	16
Costa Rica	1	1	1
Ecuador	5	6	6
Guatemala	3	1	1
Mexico	187(22)	194(28)	194(29)
Peru	15(6)	16(6)	16(6)
Trinidad	11(4)	9(4)	9(4)
Venezuela	46(14)	33(10)	31(10)
	460(84)	435(75)	433(73)
Middle East			
Abu Dhabi	40(26)	39(19)	30(19)
Bahrain	1	1	0
Dubai	5(3)	7(3)	6(2)
Egypt	35(21)	43(18)	42(23)
Iran	2	20(2)	20(2)
Iraq	22	18	18
Jordan	3	3	3
Kuwait	5	5(1)	4
Oman	10	10	10(1)
Qatar	2(2)	2(1)	2(1)
Ras Al Khaimah	1	0	0
Saudi Arabia	25(12)	18(8)	16(7)
Syria	15	19	19
Turkey	31	24	24
Umm Al Qaiwain	1	0	0
Southern Yeman	0	1	1
	198(64)	201(59)	195(55)
South Pacific			
Australia	24(12)	30(10)	30(10)
New Zealand	2	3(2)	3(2)
Papua New Guinea	1(1)	2	2
	27(13)	35(12)	35(12)
Totals	1,322	1,220	1,206
	(348)	(330)	(329)

Letters

TO THE EDITOR:

Please refer to your article in News Hi-Lites for February 1984 (p. 2) on Loffland Brothers Co., who claim to hold the world record for holding the longest continuous contract with one company for drilling oil wells on land. Marine Drilling Co. has had continuous drilling contracts with Belco Petroleum Corp. of Peru, drilling slant and vertical wells from fixed platforms offshore Peru, since 1966.

We do not claim a world record, but we do feel that our continuous performance is worth mention.

H. B. Robeson
Marine Drilling Co.
Corpus Christi, Tex.